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**Multiannual Programme
of the Joint Research Centre
1980-1983**

1980 Annual Status Report

Nuclear measurements

NUCLEAR MEASUREMENTS

1980

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PROJECTS

- project Measurements of Nuclear Data:
 - neutron data
 - non neutron nuclear data
- project Nuclear Reference Materials and Techniques:
 - nuclear reference materials
 - samples and targets for nuclear measurements
 - development of reference techniques
 - study for the production of enriched actinide isotopes

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1. INTRODUCTION

The JRC programme "Nuclear Measurements" is carried out exclusively by the Geel Establishment (the Central Bureau for Nuclear Measurements, CBNM), and forms by far the largest fraction of the work commitment of that Establishment. It conforms closely with the aim of the Establishment as envisaged in the original Treaty establishing the European Atomic Energy Community. It is also a logical continuation of the nuclear section of the Programme METRE which formed part of the JRC programme existing in the previous period. In addition it is designed to extend the exploitation of the CBNM's major nuclear measurement facilities, the performances of which have been increased and improved in recent years. These include the two large accelerator installations (the electron accelerator and the Van de Graaff) and the mass spectrometers. The Nuclear Measurements programme is divided into two main projects, Nuclear Data on the one hand and

Nuclear Reference Materials and Techniques on the other. In the former the JRC actions form part of world wide sets of actions to establish reliable, and in many cases very precise, figures for important nuclear parameters - e.g. neutron interaction cross-sections, isotope half-lives - needed for the development and exploitation of nuclear energy for peaceful purposes. In this work the CBNM pays particular attention to the specific needs of the Community and to complement similar actions undertaken in the laboratories belonging to the Member States.

Concerning Nuclear Reference Materials and Techniques the actions are to provide materials to which analytical and other measurements carried out in the nuclear industry or by the nuclear community can be referred. One or more of the properties of the materials must therefore be well characterized and eventually certified and in order to

carry this out effectively the important techniques used for characterization must be continuously examined and if possible improved.

The basic aim of the Nuclear Measurement programme is therefore to develop the science of nuclear metrology with special orientation towards satisfying the demands for basic nuclear data and for materials and methods of reference.

2. RESULTS

Measurements of Nuclear Data

This project is divided into two parts, one concerned with data pertinent to neutron induced reactions and the other with so-called non neutron nuclear data which in this programme is mainly data on radioisotope decay.

Neutron Data

The main objective is to measure accurate differential cross-section data on reactions induced by neutrons for the development, operation and safeguarding of nuclear installations, and to improve the knowledge of the associated underlying physics. Attention is fixed primarily on the needs for fast breeder design but some reactions related to the assessment of thermonuclear fusion are also under study. Specific objectives are neutron data on nuclear fuels (the actinides), structural and coolant materials, fission products, gas producing reactions and standard neutron cross-sections (i.e. those on which other measurements can be based). Good progress has been made in the measurement of fission cross-sections on the isotopes ^{240}Pu and ^{238}Pu which are generally regarded as being non-fissile but in fact do undergo significant fission at neutron energies below the accepted threshold. A considerable amount of data on separated isotopes of the structural materials on loan from the USA has been accumulated and is undergoing analysis. An attempt is being made to resolve discrepancies

in the cross-section data on tritium breeding in ^7Li , but more data are still required.

The electron and Van de Graaff accelerators and the main computer, IBM 375/138 have been used effectively for the execution of this work. Studies on how to increase the compression of the pulses from these accelerators have been made and actions to realise these important improvements are now in progress.

Non Neutron Nuclear Data

In this section the objective is to meet the needs for information on the decay properties of radionuclides by experimental determination of the relevant data (including the development of techniques to improve accuracy) and by detailed evaluations of information already available.

Several half-life determinations, for ^{57}Co , ^{130}Rh (ground and metastable state), ^{103}Pd , ^{109}Cd and the first excited state of ^{181}Ta have been finished. Good progress has been made in the development of a technique for calibrating X-ray detectors in the energy region below 4 keV and also in the use of silicon detectors for α activity measurements.

Nuclear Reference Materials and Techniques

This project is divided into four parts.

Nuclear Reference Materials

Some years ago a survey was made of the needs of the European Community for actinide reference materials with which analytical measurements concerned with the nuclear fuel cycle could be calibrated and attention is now focused on to trying to satisfy these needs. Two types of material can be identified; those for calibrations in chemical analyses and isotopic analyses respectively.

Concerning those for chemical analyses it is believed that enough work has been carried out to provide a final certification for stocks of U and Pu metal. Similar work is proceeding for the oxides of U and Pu. In the area of isotopic references, preparation work has been carried out to perform intercomparisons of UF_6 standards from France, UK and U.S.A. Work on the preparation of synthetic mixtures of uranium isotopes of accurately known compositions continues and material to provide eventually Pu isotopic standards for destructive analyses has been obtained. Good progress has been made in the preparation of reference samples of U_3O_8 for calibrations in non destructive analyses - this in collaboration with the National Bureau of Standards, USA.

Samples and Targets for Nuclear Measurements

The provision of samples and targets for various nuclear measurements, varying from targets used in accelerating machines to in-pile dosimeters, continues to be an important service for measurers in the Community. During the year, 746 items have been delivered concerning many different applications. A new material for in-pile dosimetry based on vanadium alloy containing a known amount

(1.99 ± 0.00
 $- 0.02$ wt %) U has been developed.

A new method of preparing uniform deposits of material, based on the use of piezo-electric pulsed jet device is under development.

Development of Reference Techniques

To back up the programme points under 2.1 and 2.2 above, work is carried out on the development and improvement of nuclear analytical techniques. The improvement of the performance of mass spectrometers is under continuous observation and progress has been made in understanding factors which can influence the accuracy of isotopic abundance measurements. The photon

activation technique has been developed and applied to the analysis of river sediments and to the uptake of uranium by seaweeds.

Because of the interest of thin films in the field of nuclear measurement analysis by ion induced X-ray emission and Rutherford back-scattering techniques have been in use, the latter for example on very thin niobium films used as calibrated radioactive sources.

Study of the Production of Enriched Actinide Isotopes

Except in a few cases the European Community (EC) does not presently have the capability of producing highly enriched actinide isotopes which can be used for research purposes in the field of nuclear measurements, and it relies on availability from outside the EC, especially the USA. Consequently in this programme Nuclear Measurements, the CBNM has been charged to investigate the long term future requirements for such isotopes and the possible ways in which they may be produced. Progress has been made in compiling the present stocks, in assessing production methods and in assembling computer codes for exploring those methods involving in-pile irradiations. Since ^{244}Pu has been identified as an isotope of special importance some experiments to determine the yield of the isotope in the in-pile irradiations of ^{242}Pu have been started.

3. CONCLUSIONS

The execution of the Nuclear Measurements Programme relies on mutual collaboration with external organizations and it would be impossible to mention them all in this short summary. The continuation of collaboration with the SCK/CEN in the field thermal and resonance neutron data measurements and the collaboration of several analytical laboratories belonging to Member States in

the characterization of elemental reference materials deserve special mention.

No severe difficulties have been met in phasing the previous programme METRE into the new programme Nuclear Measurements which is now totally nuclear. In order to free manpower to work on the study on the production of Enriched Actinide Isotopes, the effort on nuclear data measurements has had to be reduced slightly and this has resulted in CBNM withdrawal from neutron cross-section measurements in the thermal region using a reactor beam. Otherwise the programme is proceeding along the lines of its objectives.

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